of cloud according to Howard's nomenclature. His classification by quadrants shows that the same law holds good for all directions as well as for all kinds of clouds, viz, for all altitudes. Combining the four quadrants, his figures show that the lower scud is inclined outward to the wind by 14.5°, the cirro-stratus current is inclined 22.8°, and the current of the true cirri is inclined outward 29.6°. Having, from his wind observations, found that the average or resultant direction of the surface wind at Makerstoun is from the point west 21° south, it follows that, in general, the resultant scud is from west 7° south, the cirro-stratus from the west 2° north, and the cirrus proper from west 9° north. Broun includes cumulus with scud.

The law deduced by Broun for Makerstoun, i. e., that the upper currents are deflected to the right of the lower, has a general application to the whole Northern Hemisphere.

SEASONAL FORECASTS IN INDIA AND AMERICA.

During the past fourteen years the meteorological office at Calcutta has regularly published in May or June a memorandum giving all the accessible data relative to recent snowfall, rainfall, pressure, temperature, and wind that seemed in any way to bear upon the possibility of forecasting the probable character of the approaching southwest monsoon winds and rains. Such seasonal forecasts can undoubtedly be utilized by many classes of citizens, and the extent to which they are so used must depend largely upon the accuracy with which the season can be forecast.

The memorandum and monsoon forecast for 1898 was published on June 3 of this year by Mr. John Eliot, Meteorological Reporter to the Government of India.

The following is a summary of the chief features of the meteorology of India during the past six months, which are most likely to influence the advance of the monsoon currents and the distribution of the monsoon rainfall:

1. The snowfall of the past winter has undoubtedly been much less than usual over the whole of the western Himalayas and probably also in Afghanistan. It was probably in local excess in Chitral and perhaps in Baluchistan, due chiefly in the latter area to heavy precipitation in December and March. There was a heavy and somewhat abnormal fall in the second week of May over the whole of the western Himalayas (as was also the case in 1883, 1884, and 1888).

2. The pressure conditions in India during the past five months were such as accompany higher temperature in northern India and less snowfall than usual in the western Himalayas, and probably also the eastern Himalayas. The chief features, which have been remarkably persistent, are (*a*) general deficiency of pressure, (*b*) local deficiency in northern India and Burma, most marked in Bengal and Burma, and (*c*) local excess in western India, greatest in Sind, Kathiawar, and the Konkan.

3. The temperature conditions during the past five months are such as usually accompany a more open and drier winter than usual (with scanty snow) in the Himalayan area. Temperature was largely in excess in April and in moderate excess in May. The excess in these months was, on the whole, most pronounced in northwestern India and the north Deccan.

4. The air has been throughout nearly the whole season much drier than usual and skies remarkably free from cloud.

5. The air movement was more vigorous than usual in March and April, due to the intensified thermal conditions of the period in the interior of India.

6. Hence, the snowfall in the Himalayan area has been of such a character as not to impress any conditions upon the pressure distribution, temperature, and air movement in northern and central India unfavorable to the early or full extension of the monsoon currents in their progress northward from the equator.

It may be noted that some of the abnormal features of the meteorology of India during the past seven months have been related to abnormal conditions prevailing in Persia and southeastern Europe. Anticyclonic conditions obtained to a most unusual degree in southern Europe from November onward, and, as a consequence, cool, dry, northwest winds prevailed in Persia with remarkable persistence from November to February. This abnormal air movement extended across Baluchistan and the north of the Arabian Sea into northwestern India, and has undoubtedly contributed to the unusual dryness of the air and freedom from cold-weather storms of the period in northern and central India.

After discussing the special features of the weather and monsoons since 1879, Mr. Eliot makes a detailed forecast for the southwest monsoon and rains of 1898, as follows:

The southwest monsoon rains will probably commence not later than the end of the first week of June on the coast of Bombay and the third week of June on the coast of Bengal. As to the quantity of rainfall, the general conclusion is that the rainfall may be deficient to a slight or moderate extent, depending chiefly upon the strength of the monsoon in Sind, Cutch, the north and west Punjaub, and west Rajputana; that it will very probably be at least normal in amount in central India and the northern half of the Peninsula, except, perhaps, Berar, Khandesh, and the west Deccan, and may be in moderate excess in the eastern half of the northwestern provinces, Bihar, the central provinces, and the eastern states of central India. It will probably be normal or in excess in Burma, Assam, and perhaps in east and north Bengal, and may be in slight defect in west Bengal.

In nearly all parts of the world the rainfall goes hand in hand with the distribution of pressure and wind, and, in fact, follows after these. It would not be surprising, therefore, if we should eventually be able to do for portions of the United States as well as Blanford and Eliot have done for India.

EARTHQUAKES IN NEW BRUNSWICK.

Mr. Samuel W. Kain has published in the bulletin of the Natural History Society of New Brunswick a list of all the earthquakes on record in that Province, together with such details of each as seem worthy of preservation. The following list of dates is taken from his work:

The times given by him are those of St. John local time, which may be reduced to seventy-fifth meridian time by subtracting 35′ 44″.

1663, February 5, 5:30 p. m. to 8 p. m.
1755, November, on several dates.
1764, September 30, about noon.
1817, May 22, 3:31 a. m.
1824, July 9.
1855, February 8, 6:30 a. m.
1860, October 17, 6:25 a. m.
1869, October 22, 5:48 a. m.
1870, March 17, 6 to 8 a. m.
1870, October 20, 11:40 a. m.
1882, December 31, 9:56 p. m.
1884, January 26.
1885, June 10, 10 a. m.
1896, March 22, 7:56 p. m.
1896, May 15, 11 p. m.
1897, January 26, a. m.
1897, January 28, 9 p. m.
1897, February 14, 9 p. m.
1897, September 25, 1:30 p. m.
1897, October 12, 10:35 p. m.
1898, January 11, 2 a. m.

Concerning each of these Mr. Kain gives such other details as are accessible to him, and will, of course, be pleased to hear from those who can add to the list. He notes the great frequency of earthquakes at Grand Manan, and that shocks are of frequent occurrence in the Bay of Fundy, where they are generally spoken of as the reports of cannon. In regard to this point, Dr. George F. Matthew said:

This part of the Bay of Fundy is remarkable for its great depth and precipitous shores. Off Brier Island the bottom descends to a depth of 100 fathoms in a distance of three miles from the outermost ledge; it is almost equally abrupt on the Grand Manan slope; the trough between is deeper than the bottom of the Gulf of Maine outside adjoining. This is the only part of the Bay of Fundy where there have been heavy outflows of trap of Triassic age on *both* sides of the bay, and the abyss between may be complementary to these ejections of lava. The weakness of the earth's crust here in Triassic times, as shown by the volcanic eruptions of that age, may not even yet be altogether removed; but the greater tendency to earthquake movements in this district may be the dying throes of the old Triassic disturbances.

RECENT EARTHQUAKES.

Prof. E. W. Morley, at Cleveland, Ohio, and Prof. C. F. Marvin, at Washington, D. C., report no disturbance on their seismoscopes during the month of June. The following ad-

ditional notes have been received, giving the dates and locations of slight shocks:

June 3.—*Washington*, Lakeside, slight, time not given.

6th.—*Kentucky*, Richmond, 2:30 a. m.

8th.—*California*, Ukiah.

9th.—*California*, Upperlake, 12:45 p. m.; Ukiah.

11th.—*Vermont*, Vernon, 1:45 a. m.; jarred the house. *California*, Ukiah.

14th.—*Alabama*, Riverton, slight. *Arkansas*, Corning, 9:20 a. m.; Osceola, 9:28 a. m. *Kentucky*, Blandville, Owensboro, and Union City, at about 9:15 a. m. *Missouri*, New Madrid, 9:20 a. m., several seconds' duration; Gordonville, 9:25 a. m. *Tennessee*, Bolivar, Wildersville, and Savannah, 9:30 a. m.; Memphis, 9:25 a. m., lasting two minutes. *Indiana*, Evansville, 9:30 a. m.

23d.—*California*, Descanso, 1:44 p. m.

24th.—*California*, Descanso, 2:45 p. m.

26th.—*Kentucky*, Richmond, 2:30 a. m.

30th.—*California*, Los Angeles, 11:28 p. m., shock from southwest to northeast of about two seconds' duration. The shock seems to have been of a local character. Articles were thrown about, and a rumbling noise was heard. No reports of a quake from any neighboring city were received, notwithstanding numerous inquiries.

MATHEMATICS AND METEOROLOGY.

A student asks that a brief course of mathematics be laid out for him which will fit him to teach meteorology to ordinary college classes. He does not himself wish to go into extended research work in mathematical meteorology, but he wants to get enough mathematics to give him an understanding of meteorological text-books and articles. His present preparation is that ordinarily pursued for entrance into the freshman class, namely algebra, plane geometry, and plane trigonometry.

Assuming that the applicant wishes to teach the correct theory or explanation of meteorological apparatus, such as is given in the "Treatise on Meteorological Apparatus and Methods," published in the Report of the Chief Signal Officer for 1887, and that he also wishes to thoroughly understand, if not teach, the thermodynamics implied in such text-books as those of Ferrel, Davis, and Waldo, and which forms the vital part of dynamic meteorology, and that he, furthermore, wishes to fortify himself as to fundamental principles which should guide one in the study of statistical climatology, it is probable that his wisest course is to spend at least two years more in the study of pure mathematics, and, also, two years in practical work in the laboratory on experimental and theoretical physics. Assuming that his lectures and text-books must be in the English language, we can in the following lines refer only to a limited number of works in that language, but, if any way possible, the student should be careful to select as his teacher or adviser one who is familiar with what is published in other languages.

The first step must be to conquer solid geometry, spherical trigonometry, and analytical geometry, to which end one may take almost any one of the serial school text-books, such as those of Bowser, Chauvenet, Loomis, Newcomb, Todhunter, Wells, Wentworth, or Williamson.

Next to these analytical treatises graphics must claim his attention, viz, perspective, descriptive geometry, the projections of the sphere, as applications of these are continually occurring in meteorological work.

The mechanics of masses, whether solid, liquid, or gases, is, of course, fundamentally important, and before attacking the more difficult treatises it is advisable to study some elementary work, such as Smith's Elementary Mechanics, which was first prepared in 1849 for the students at Wesleyan but was subsequently taught to the students of the Naval Academy at Annapolis. In connection with this, read the Elementary Mechanics of Oliver J. Lodge and, also, Clerk Maxwell's little manual, Matter and Motion.

As some knowledge of the whole range of physics is essential, the student may take up for elementary home reading the admirable Everett's Translation of Deschanel, and will also profit as to more recent discoveries by reading Barker's Physics in that connection. The first part of Deschanel has to do with mechanics and should be read in connection with works previously mentioned. The chapter of Deschanel on heat should also be read in connection with the special treatises of Maxwell, Stewart, Tillman, or Tait in order that the student may get the elements of thermodynamics clearly before his mind.

The preceding will prepare one for nearly all that is necessary in order to understand my Treatise on Meteorological Apparatus and Methods, most of which, in fact, the student should have read as he progressed in the study of physics.

As a guide to reasoning upon statistical climatological data, some treatise on probability, such as Merriman's Least Squares, may now be read, after which the student will proceed with ease through the Short Memoirs, translated in the Smithsonian Report for 1877.

The student should now prepare himself to study and appreciate thermodynamics and hydrodynamics. He will, already, have learned something about these from the works on physics above mentioned, but he will not make satisfactory progress in reading recent works in which these are applied to meteorology without first mastering the elements of the Calculus, for which study there are several excellent treatises, such as those of Bowser, Byerly, Courtenay, Todhunter, Williamson, to which should be added some treatise on differential equations, such as that of Boole or Johnson, and some treatise on the potential function, such as that of B. O. Peirce. From these he may proceed to such works as Bartlett's Analytical Mechanics, Tait's Thermo-Dynamics, and Lamb's Hydrodynamics. Selected portions of the latter work may be chosen for their special bearing on atmospheric motion, and as preliminary to reading the translations of memoirs on the Mechanics of the Earth's Atmosphere, published by the Smithsonian Institution in 1893.

This seems a rather long journey before entering the realm of current literature in dynamic meteorology, but these are the royal gates through which one would prefer to pass in order that he may fully appreciate the present and future of our science. The path would be shortened if one or two special treatises were available for this purpose, or if one could read with another who had previously gone over the whole ground. In fact, much of this was condensed by Ferrel into one volume, viz, his Recent Advances, published in 1885, which is very convenient for reference, but is thought to be too difficult to commend to the young student.

METEOROLOGY BY CORRESPONDENCE.

The so-called system of university extension in which it is sought to bring to the very doors of the homes of distant students many of the privileges enjoyed by those who study in person within the halls of the great universities is generally considered as applicable, especially to the study of philosophy, languages, and history, but not with great success to the physical sciences, since any advanced course in the latter demands an extensive laboratory apparatus. Among the sciences, descriptive botany, mathematical astronomy, mechanics, and pure mathematics have been included in the university extension work, but meteorology among others has been omitted, as far as we are aware. Now our experience assures us that there really is a widespread popular desire to come to a